

The topics of work for the JVT meeting, as pre-announced, consisted of progressing the work relating to the Advanced Video Coding standard known in ITU-T as Recommendation H.264 and in WG11 as ISO/IEC 14496-10 or MPEG-4 part 10, considering in particular:

- Review of the work assigned to ad-hoc groups at the twelfth meeting in Redmond, including:

Title	Chair(s)
JVT Project Management and Errata Reporting (jvt-experts@mail.imtc-files.org)	Gary Sullivan, Ajay Luthra, and Thomas Wiegand
JM Description and Reference Software (jvt-experts@mail.imtc-files.org)	Thomas Wiegand, Karsten Suehring, Siwei Ma, Keng Pang Lim
Fidelity Range Extensions Text Editing (jvt-experts@mail.imtc-files.org)	Gary Sullivan, Detlev Marpe, Thomas Wiegand, Tom McMahon, Ajay Luthra
Bitstream Exchange and Conformance (jvt-bitstream@mail.imtc-files.org)	Teruhiko Suzuki and Lowell Winger

- Progression of work on development of a conformance specification for the Fidelity Range Extensions
- Progression of work on development of reference software for the Fidelity Range Extensions
- Progression of work on a test model description of example encoding practices
- Collection of reports of any errors in the video coding specification or its conformance and reference software specifications toward creation of a corrigendum or implementer's guide
- Addressing needs for coordination with the parent bodies
- Addressing needs for coordination for the definition of methods of carrying the video content in use with a variety of system designs and network environments.

As pre-announced, the meeting would also consider needs for the conduct of communication with other organizations in regard to the work of the JVT; and other business as necessary for JVT consideration could be conducted.

2 Opening remarks and ad-hoc reports of the JVT meeting

The rapporteur noted the following for the participants:

- Participants were reminded of the JVT and parent-body IPR policy, were urged to follow that policy, and were directed to the parent-body web sites for further information about the policy
- We believe the consideration of errata reports on the H.264/AVC specification to be an especially high priority for this meeting. Input document JVT-M010 is particularly noteworthy toward that goal.

- Also important for consideration to aid deployment of the standard are work toward conformance specification and reference software development. The group should also facilitate and encourage interoperability testing to the extent feasible for our organization.

Some recent developments in the JVT include:

- Completion of the FRExt amendment and the editing work for integration of that amendment with the base text.
- Completion of the reference software and conformance specifications for the Baseline, Main and Extended profiles
- A new release of FRExt-capable reference software (JM 9.0) that unifies the previously-divergent codebases used for FRExt and non-FRExt reference software
- Submission for consideration at this meeting of a draft manual describing the use of the reference software (JVT-M012)

We also note some recent developments in the community that may be of interest to our participants:

- The application community appears to be progressing well with widespread adoption of H.264/AVC with final specification or good progress toward final specification of H.264/AVC use in the application communities of IETF AVT, 3GPP (rel 6), 3GPP2, ATSC, DVB (TS 102 005 and TS 101 154), DVD Forum, Blu-ray Disc Association, DMB (Korea), ARIB (Japan mobile segment broadcast), and US DoD MISB (and of course MPEG and the ITU-T).
- The High profile recently completed as part of the FRExt extensions appears to have strong momentum for adoption – possibly even overtaking the Main profile as the primary profile expected to be deployed in large-volume entertainment-quality applications. Evidence of the adoption momentum for the High profile can be seen in recent actions of the DVB, Blu-ray Disc Association, and DVD Forum.
- A special session was held on advances in H.264/AVC video coding at the recent SPIE SPIE Conference on Applications of Digital Image Processing XXVII. That special session included a new overview paper which appears to be the first overview published that includes technical review of the new FRExt profiles, which is available at <http://fastvdo.com/spie04>. Another paper at that conference discusses the subjective testing methodology used in the MPEG AVC verification tests (it is available at <http://www.itl.nist.gov/div895/papers>, along with a related paper describing the verification tests themselves).

A timeline of upcoming events and milestones was discussed as follows:

- Currently, FRExt drafting done in September, is sitting in ITTF queue waiting for FDAM ballot
- Oct 22, MPEG meeting, new corrigendum WD → DCOR
- Nov 16-26, ITU-T SG 16 meeting, ITU "Consent" for FRExt, all conformance, and all reference software, and new corrigendum
- Approx Jan 15 ITU-T last call ends – final if no comments
- Jan 17-21, MPEG meeting, FRExt conformance and FRExt reference software both PDAM → FPDAM

- Approx Mar 1 ITU-T additional review ends if comments have been received – final if no comments
- Apr 18-22, MPEG meeting DCOR → COR
- July 25-29, MPEG meeting, FRExt conformance and FRExt reference software both FPDAM → FDAM

JM text and reference software AHG work is discussed in JVT-M004, including.

- Reference software status (non-FRExt JM 8.6, FRExt 2.2, and unified 9.0 releases noted).
- Also notes the draft reference software manual input to this meeting, JVT-M012.
- The reference software has full FRExt capabilities (all color formats, transform modes, RCT, etc).

FRExt text editing was completed with no substantial difficulties, as noted in JVT-M005.

JVT-M006 discusses bitstream exchange and conformance activities, with further discussion noted as follows.

- Bitstream exchange work done for High profile. Need more CAVLC bitstreams. Most features verified.
- Any potential problem with copyright on conformance bitstreams? There is a presumption in both committees that contributed material can be used. We have consulted with the secretariats of both parent bodies and we believe we can move ahead on that basis.
- The following features are still missing. However, the listed companies have volunteered to provide the bitstreams by November 5:
 - Alpha (not the highest priority) [Apple]
 - Monochrome [Broadcom]
 - 4:2:2 10 bit [Sony]
 - CABAC with 4:2:2 [Sony]
 - 8x8 transform with 4:2:2 [Sony]
 - Explicit Q-matrix with 4:2:2 [Sony]
 - RCT (4:4:4) [Samsung]

See also section 4.3.2 for additional remarks on conformance issues.

3 Access to JVT documents and email reflector

The primary JVT email reflector is jvt-experts@mail.imtc.org. The subscription and unsubscription method for this reflector is the use of the web link <http://mail.imtc.org/cgi-bin/lyris.pl?enter=jvt-experts>.

The JVT bitstream exchange and conformance bitstream email reflector is jvt-bitstream@mail.imtc.org. The subscription and unsubscription method for this reflector is the use of the web link <http://mail.imtc.org/cgi-bin/lyris.pl?enter=jvt-bitstream>.

The JVT ftp site can be accessed as follows.

- Older files and files of this meeting are available by ftp at <ftp://standards.polycom.com>. Anonymous access is sufficient for access to all documents of this meeting. If anonymous access is not working properly with some clients, the same access privileges can be obtained

using the user ID "jvttest" with the password "tester". For certain members-only restricted-access documents of previous meetings available only to members of the JVT, the rapporteur can be contacted for a members-only password.

- Since some participants have experienced some problems with access to the new site, we have also set up the files for the current meeting at an alternative ftp site hosted by the ITU at <ftp://ftp3.itu.int>, which can be accessed using the user ID "avguest" and the password "Avguest". These files can also be accessed (without a password) at the http link <http://ftp3.itu.int/av-arch/jvt-site>.
- NOTE – Some access problems can be fixed by toggling your ftp access tool between "active" and "passive" modes of ftp, or by using alternative ftp access tools (e.g., using the command line ftp tool or ws_ftp rather than a browser).

We wish to express our great thanks to the IMTC for hosting our email reflectors and for formerly hosting our ftp site. We also wish to express our thanks to Polycom and the ITU for their current hosting of the JVT files.

The web site for reference software of the JVT, that is maintained by Karsten Suehring, our decoder reference software coordinator, is found at <http://iphome.hhi.de/suehring>.

NOTE – The above web site address has recently changed.

We wish to express our great thanks to Karsten Suehring and the Heinrich Hertz Institute for maintaining that web site.

4 Contributions to the JVT meeting

4.1 List of documents of the JVT meeting

Documents of the meeting consisted of the following. The rapporteur asked if there was any objection to consideration of late documents, and no objection was raised.

JVT-M000 List of documents of Palma meeting

JVT-M001 Report of Palma meeting

JVT-M002 Report of Redmond meeting

JVT-M003 [G. Sullivan, A. Luthra, T. Wiegand] AHG Report: Proj mgmt and errata

JVT-M004 [T. Wiegand, K. Suehring, S. Ma, K.P. Lim] AHG Report: JM text and ref soft

JVT-M005 [G. Sullivan, D. Marpe, T. Wiegand, T. McMahon, A. Luthra] AHG Report: FRExt text editing

JVT-M006 [T. Suzuki, L. winger] AHG Report: Bitstreams & conformance

JVT-M010 [Sullivan] Input on corrigendum

JVT-M011 [Suzuki] Input on FRExt conformance

JVT-M012 [Tourapis] JM software manual

JVT-M013 [I. Choi, J. Lee, W.-I. Choi, B. Jeon] Perf eval fast mode decision

JVT-M014 [D. Marpe, V. George, T. Wiegand] Perf intra H.264/AVC HP vs. JP2k

The creation of the following output documents was **authorized:**

JVT-M041 [JVT] Draft H.264/AVC Conformance

(Document for ITU-T SG 16 Consent as Rec. H.264.1)

JVT-M045 [JVT] Draft H.264/AVC Fidelity Range Extensions Conformance

(WG 11 N6740 Study of ISO/IEC 14496-4:2004/PDAM9)

JVT-M046 [JVT] Test Model Reference Encoding Method Description and Decoder Error Concealment Method Description

JVT-M048 H.264/AVC Reference Software

(Document for ITU-T SG 16 Consent as Rec. H.264.2 and WG 11 N6743 Study of ISO/IEC 14496-5:2001/PDAM8 AVC Fidelity Range Extensions Reference Software)

JVT-M049 [JVT] Draft Technical Corrigendum to H.264/AVC Version 3

(WG 11 N6711 Text of ISO/IEC 14496-10:2005/DCOR1 Corrigendum to Advanced Video Coding 3rd Edition)

JVT-M050 [JVT] Draft of Version 4 of H.264/AVC

(Document for ITU-T SG 16 Consent as new edition of Rec. H.264)

Regarding editing of output documents – drafts should be provided by the editors as the work progresses – broad discretion is given to the editors to do what is necessary to finalize these texts, subject to email consensus if any problems should arise in the progress of that work.

Agreed.

4.2 Categorization of JVT documents

The principal contributions were categorized as follows.

- **JVT-M010:** Input on corrigendum
- **JVT-M011:** FRExt conformance
- **JVT-M012, JVT-M013, JVT-M014:** Reference software, test model and performance analysis

4.3 Discussion of JVT contribution documents

4.3.1 JVT-M010 [Sullivan] Input on corrigendum

A very large part of the meeting was devoted to consideration of this input contribution. Each item was reviewed and a plan for action was discussed for each. The details of the disposition of the specific items are recorded in the output draft corrigendum document. It was **agreed** that we should progress to finalization based on that output document, plus any new corrections that become identified (with discussion by email and ftp document exchange), with discretion for final editing work (including details of disposition of existing and new items) given to the editor.

4.3.2 JVT-M011 [Suzuki] Input on FRExt conformance

Good progress was noted. It was **agreed** that we should progress to finalization based on that document, plus any new material that becomes available, with discretion for final editing work given to the editor.

The availability of new Non-FRExt bitstreams – it was **agreed** to include those in with the FRExt conformance amendment in WG 11. We think there is not necessarily a need to change the title.

It would be nice to have bitstreams that test the interpretation of corrigendum items, including

- PicAFF with PT SEI
- MaxvMvR vertical range for chroma for field mode macroblocks

- Chroma vertical edge deblocking at boundary of macroblocks in MBAFF (this we already have)
- Any other such items as can be identified

WG 11 NB comments are encouraged to help move this forward.

See also section 2 for additional remarks on conformance issues.

4.3.3 JVT-M012 [Tourapis] JM software manual

A draft manual for the reference software was provided. It was **agreed** that if there is no problem procedurally, and we can improve it sufficiently, we should improve this and include it in the FReXt reference software amendment. However, it does need some work and thus may not be sufficiently mature for November ITU-T Consent.

4.3.4 JVT-M013 [I. Choi, J. Lee, W.-I. Choi, B. Jeon] Perf eval fast mode decision

Performance evaluation of fast intra prediction functionality in test model and reference software.

Used in fast high-complexity mode

Fast mode decision schemes in JVT test model were outlined as follows.

- "M1" JVT-K021/JVT-J033 Early skip/direct detection
- "M2" JVT-K021 Selective intra coding
- "M3" JVT-I020 Fast intra prediction
- "M4" JVT-G013 Fast inter mode selection

Remark: Need to keep improving JM text

QCIF test done, JM7.5

Remark: It would be nice to have HD or MBAFF SD

The low complexity mode had a serious negative impact on quality (4% for IPPP, 18% for IBBP) and did not improve speed much.

M1 through M4: 2%.

M1 and M2 only: No impact on quality and big time savings.

If the results are correct, our current low complexity mode does not make sense (unless we improve it in some way).

Also, M3 and M4 do not appear justified in this – they save only a few percent in processing time and they result in a loss of video quality.

But reference software does not offer the ability to just use M1 and M2 – only M1 through M3 together, or slow high complexity mode or low complexity mode.

It would be nice to have that ability in the software.

Perhaps the results would be different on different sequences.

Two conclusions:

- We need to either fix or remove the low complexity mode
- We ought to enable the software to be more flexibly configured regarding M1 to M4 switching

4.3.5 JVT-M014 [D. Marpe, V. George, T. Wiegand] Perf intra H.264/AVC HP vs. JP2k

This was an information contribution on the subject of the effectiveness of the intra coding in the the H.264/AVC High profile, particularly relative to the state of the art in still-image coding as represented by the JPEG-2000 standard. The same contribution was presented to VCEG.

(Also tests monochrome support in JVT reference software.)

Test included 14 monochrome test images, in three categories

- Photographic images
- Miscellaneous images
- Compound images (mixture of text & graphics & photos)

Intent is to provide information on intra capability of H.264/AVC. Took Taubman/"Kokadoo" variant of JPEG-2000 and ran it in non-scalable mode and compared it using 8-bit data with High profile monochrome intra and other profiles using an image test set used frequently in JPEG-2000 work.

For JPEG-2000, used default (9/7 wavelet) settings, 4 levels of wavelet decomposition (at high bit rates, using the 5/3 filter might be better), and single-layer non-scalable mode optimized for the tested bit rate.

Some observations: Lena 512x512 similar at lower rate, High profile 0.5 dB higher in PSNR at higher rates (44 dB, 2 bpp – good visual quality achieved somewhere around 37-38 dB). Barbara 512x512 more similar performance (in this case JPEG-2000 better). Hotel significant advantage to H.264 (0.7 – 1.0 dB). Goldhill advantage to H.264. Woman (high res) about equal in perf. Café (high res) High profile somewhat better 0.5 dB than JPEG-2000. Bike 0.3 to 1.0 dB better with High profile – visually better too. Fingerprint – JPEG-2000 significantly better (this is the only one in this set where this is true). Arial 1 H.264 slightly better.

Mixed text and picture content and artificial content – H.264 dramatically better than JPEG-2000 on these. "Target" (2-4 dB). "Cmpnd1" (3-6 dB). "Chart" (1 dB).

H.264 seems best when the picture has more detail. Crisper, sharper detail on text – less ringing around edges. But in smooth areas, some blockiness.

Loop filter significantly harming PSNR performance on one picture (with text regions). Using slices or FMO with customization of filtering on a region basis would be best (not done here).

Trying to also measure High profile versus Main profile, etc. There is a significant improvement there.

More complete results were to be made available in final document than what was presented at meeting. (Last-minute computer difficulties necessitated regenerating many results.)

How about 10 & 12 bits per sample – didn't test that.

Remark: Consider working on a joint report in order to work toward a clearer conclusion.

Remark: There was a report at the Klagenfurt meeting. Consider color effect – relative fidelity (and tuning of that fidelity by encoder QP adjustment) of luma and chroma.

Remark: Scalability and its header overhead in JPEG-2000. If header overhead is having a significant effect, that is worth knowing.

Remark: There has been extensive testing of JPEG-2000 for DCinema applications. If that material could be re-coded with FReXt, that might be valuable. (Contact Tom M. for more information.) Note difficulty of balancing luma and chroma fidelity. Does the reference

software have good RCT capability? Some bugs with more than 8 bit samples (Intra should be OK).

5 Future plans for the JVT

Planning: One more meeting in January during with WG 11 week, then if there will be future meetings, they should probably be much less frequent unless the scope of work is increased.

The JVT chairman **proposes** to hold a meeting during 18-21 January 2005 under the ISO/IEC auspices of the 71st meeting of WG 11 (17-21 January 2005) in Hong Kong, China. Plans for JVT meetings beyond that time should be established after review of JVT activity status at the November 2004 meeting of ITU-T SG 16.

6 Summary of JVT ad-hoc groups formed

The JVT provides the following list of JVT ad hoc groups appointed to progress work in the interim period until the next JVT meeting. Reports of the activities and recommendations of these ad hoc groups are requested at the next stand-alone meeting of the JVT.

Title and Email Reflector	Chairs	Mtg
JVT Project Management and Errata Reporting (jvt-experts@mail.imtc-files.org)	Gary Sullivan, Ajay Luthra, and Thomas Wiegand	N
JM Description and Reference Software (jvt-experts@mail.imtc-files.org)	Thomas Wiegand, Karsten Sühning, Alexis Tourapis, and Keng Pang Lim	N
Bitstream Exchange and Conformance (jvt-bitstream@mail.imtc-files.org)	Teruhiko Suzuki and Lowell Winger	N

7 JVT attendance

The following persons attended the JVT meeting sessions (based on an attendance sheet passed around at the meeting):

Persons attending and affiliations

1. Gary Sullivan, Microsoft
2. Ajay Luthra, Motorola
3. Thomas Wiegand, HHI
4. Scott Foshee, Adobe
5. Jani Lainema, Nokia
6. Gisle Bjøntegaard, Tandberg
7. Jung Ho Choi, Korea Telecom
8. Hideki Takehara, JVC
9. Tomokazu Murakami, Hitachi
10. Takashi Nishi, Oki

11. Stephane Valente, Philips
 12. Kimchiko Kazui, Fujitsu
 13. Tom McMahon, Dolby
 14. ChongSoon Lim Panasonic
 15. Shijun Sun, Sharp
 16. Hyun Mun Kim, Samsung
 17. Gero Bäse, Siemens
 18. Takeshi Chujoh, Toshiba
 19. Teruhiko Suzuki, Sony
 20. Aharon Gill, Zoran
 21. Detlev Marpe, HHI
 22. Peter List, Deutsche Telekom
 23. Barry Haskell, Apple
 24. Jill Boyce, Thomson
 25. Thiow Keng (T.K.) Tan, NTT DoCoMo
 26. Haoping Yu, Thomson
 27. Greg Cook, Thomson
 28. Yuriy Reznik, RealNetworks
 29. Yoshihisa Yamada, Mitsubishi Electric
 30. Frank Bossen, NTT DoCoMo
 31. Ping Wu, TandbergTV
 32. Shawn Zhong, Broadcom
 33. Feng Chi Wang, Conexant
 34. Byeong Moon Jeon, LG Electronics
 35. Tibet Mimar, Atheros Communications
 36. Sam Narasimhan, Motorola
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